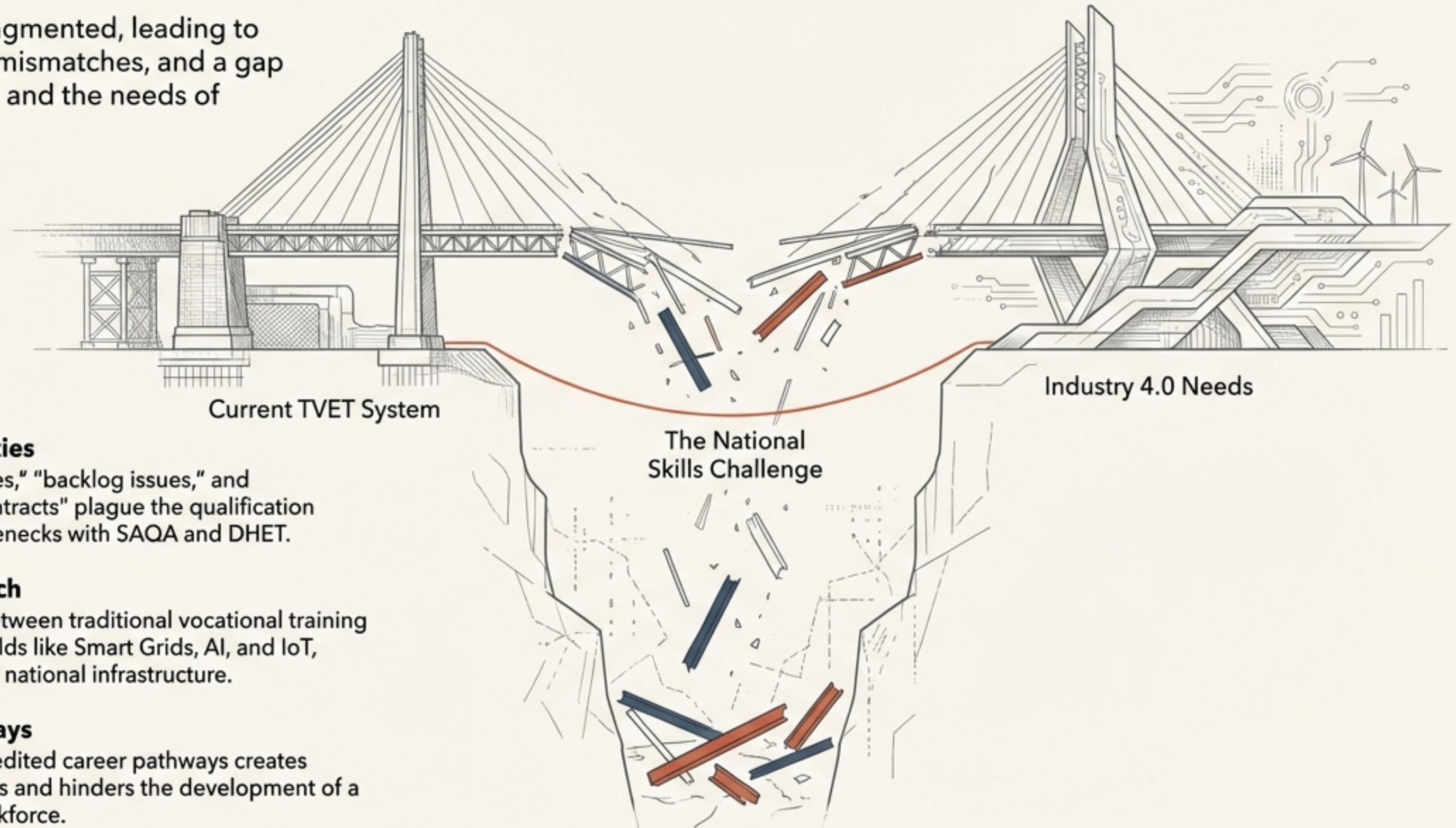


# South Africa's Technical Education Is at a Crossroads

The current framework is fragmented, leading to qualification backlogs, skill mismatches, and a gap between NATED curriculum and the needs of Industry 4.0.



## Systemic Irregularities

Persistent "irregularities," "backlog issues," and "non-performance contracts" plague the qualification system, creating bottlenecks with SAQA and DHET.



## Curriculum Mismatch

A critical gap exists between traditional vocational training and future-focused fields like Smart Grids, AI, and IoT, which are essential for national infrastructure.



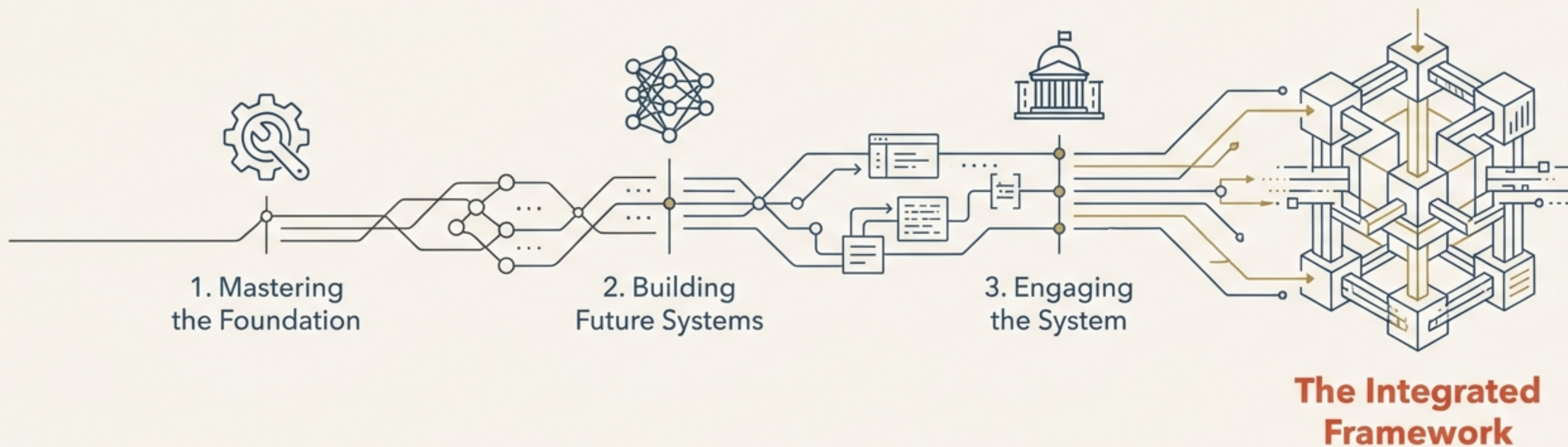
## Fragmented Pathways

The lack of clear, accredited career pathways creates uncertainty for learners and hinders the development of a technically skilled workforce.



# Forging a New Path: An Integrated Framework for Engineering Excellence

To solve this challenge, a multi-year journey was undertaken to master foundational skills, build future-ready systems, and engage the regulatory landscape. The result is a cohesive framework that bridges theory, practice, and compliance.



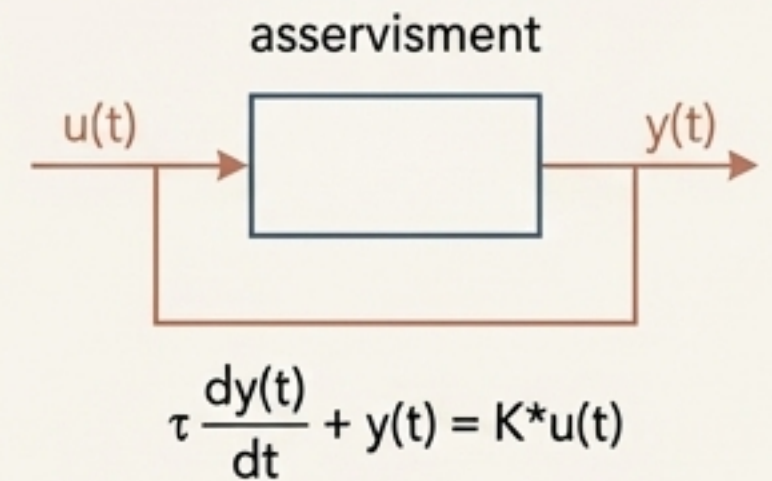
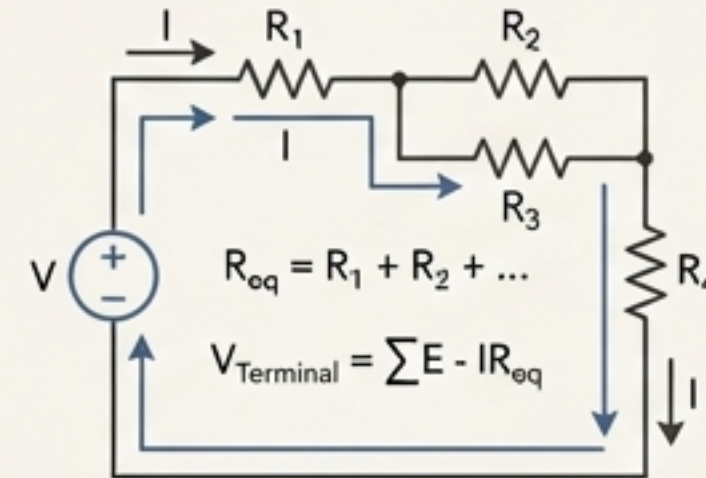


# Deep Expertise in Foundational Electrical Engineering and Trade Skills

## Key Competencies

- **Electrical Trade Theory**  
Mastery of core principles including Ohm's Law, AC/DC circuits, and power factor correction.
- **Industrial Electronics**  
Application of semiconductor devices (diodes, thyristors, SCRs) in control systems.
- **Practical Workshop Skills**  
Proficient in workshop practices including drilling, grinding, welding, and fabrication.
- **Fault Analysis & Panel Wiring**  
Expertise in diagnosing and correcting faults in control panels, distribution boards, and motor control circuits.

## Evidence Showcase



### MERSETA framework checklist:

- ✓ Use fixed and portable drilling machines
- ✓ Sharpen drills
- ✓ Prepare material for arc weld
- ✓ Tack and arc weld work piece



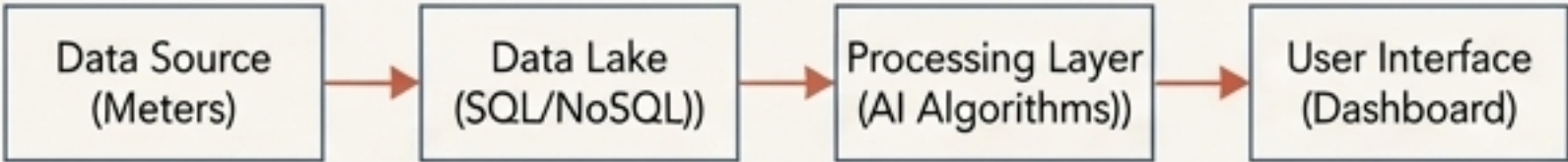
# Integrating Advanced Concepts for Industry 4.0 and Smart Infrastructure

## Key Competencies

- "Artificial General Intelligence (AGI): Exploring AGI's role in human-machine collaboration, its societal impact, and its contrast with narrow AI.
- "Smart Grids & IoT: Understanding real-time data collection, predictive maintenance for electric meters, and IoT applications in power systems.
- "Cybersecurity & Hacking: Principles of network security, including SSL/TLS protocols, threat analysis (POODLE, Heartbleed), and data protection.
- "Renewable Energy Systems: Exploring solar, wind, and hydro energy conversion, system efficiency, and e-commerce strategies for the renewable sector.

## Evidence Showcase

- AGI in Human-Machine Collaboration
- Smart Grids and IoT Applications
- Cybersecurity and Hacking
- Online Retail and E-commerce in the Renewable Energy Sector



- CRISPR
- Blockchain Consensus Mechanisms
- Robotic Process Automation (RPA)

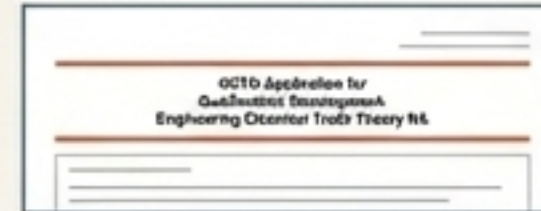


# Proactively Navigating the Regulatory and Funding Landscape to Drive Reform

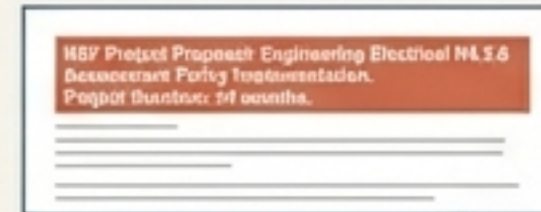
## Key Engagements

- **"Qualification Development"**  
Formal submission to the Quality Council for Trades & Occupations (QCTO) to develop and realign the 'Engineering Electrical Trade Theory N4' qualification, addressing systemic gaps.
- **"National Funding Proposals"**  
Application to the National Skills Fund (NSF) for an 'Engineering Electrical N4,5,6 Assessment Policy Implementation' project, targeting youth unemployment and skill development.
- **"Research & Development Incentives"**  
Successful application for the DSI R&D Tax Incentive program for a project in 'Engineering Electrical,' linking innovation to fiscal policy.
- **"Labour Relations & Compliance"**  
Deep analysis of labour law, including the Labour Relations Act (LRA), CCMA processes, and private security sector bargaining council agreements, to ensure frameworks are legally sound.

## Evidence Showcase



QCTO Application for Qualification Development: Engineering Electrical Trade Theory N4.



**NSF Project Proposal:** Engineering Electrical N4,5,6 Assessment Policy Implementation.  
**Project Duration:** 24 months.



DSI R&D Tax Incentive Notification of Approval.  
Registration No: 2013/034490/07.

- Labour Relations Act 66 of 1995
- Basic Conditions of Employment Act
- CCMA rules



# The Solution: An Integrated Framework for Technical and Vocational Excellence

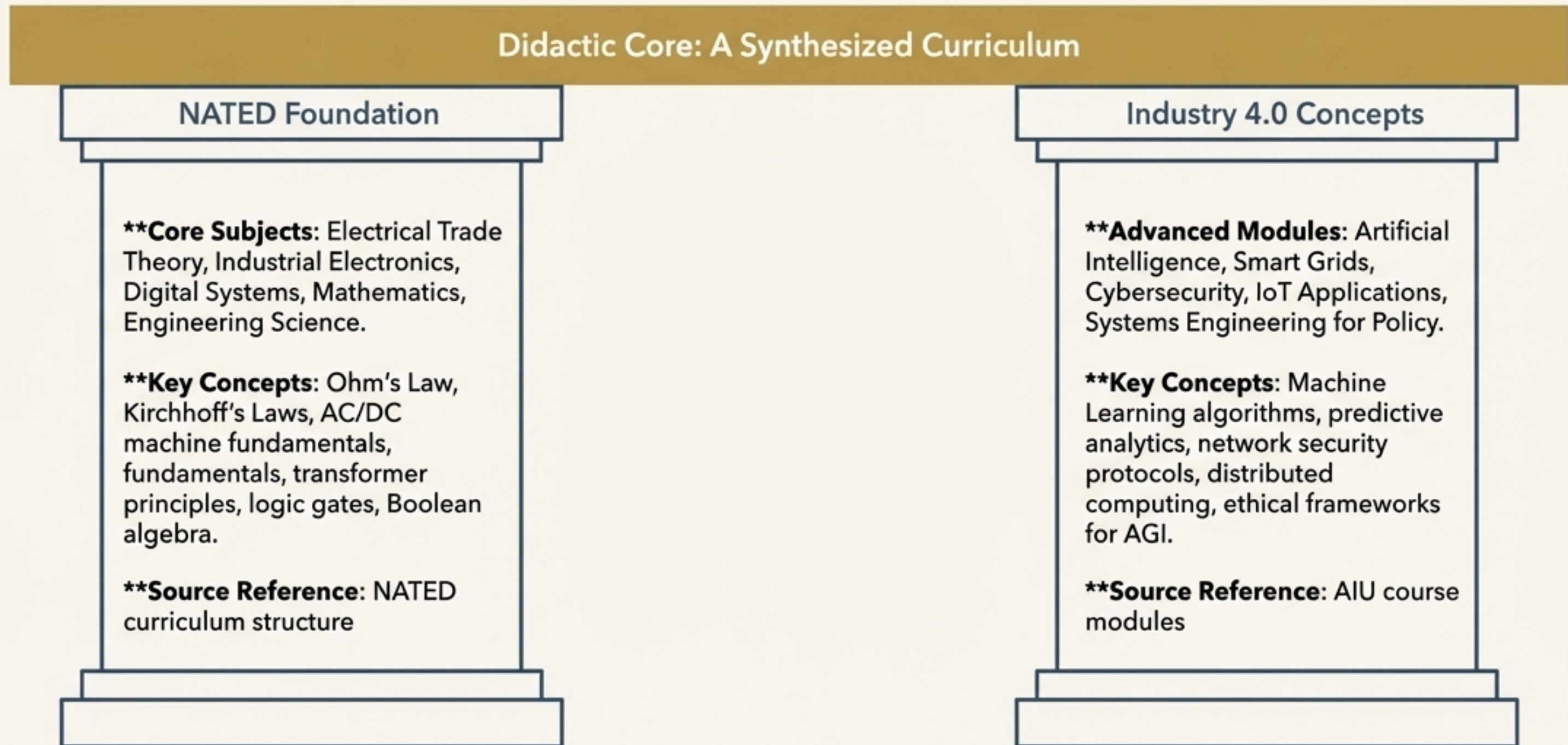
The Tshingombe Integrated Framework is a holistic, multi-layered model that synthesizes foundational theory, advanced concepts, practical application, and regulatory compliance into a single, cohesive educational pathway.





# Framework Component 1: The Didactic Core

## A Curriculum Blending Foundational NATED Theory with Advanced Systems Thinking





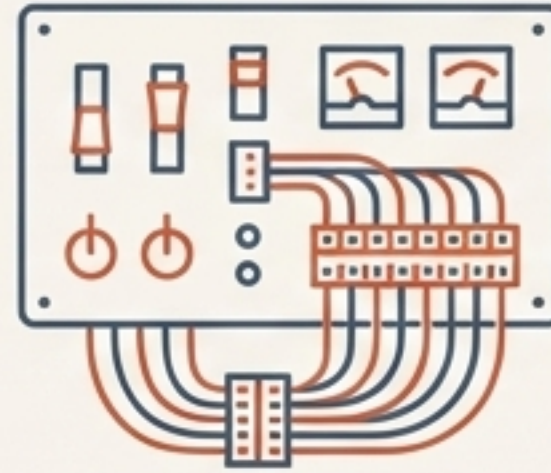
# Framework Component 2: The Practical Engine

## Project-Based Learning Rooted in Workshop Mastery and Real-World Application



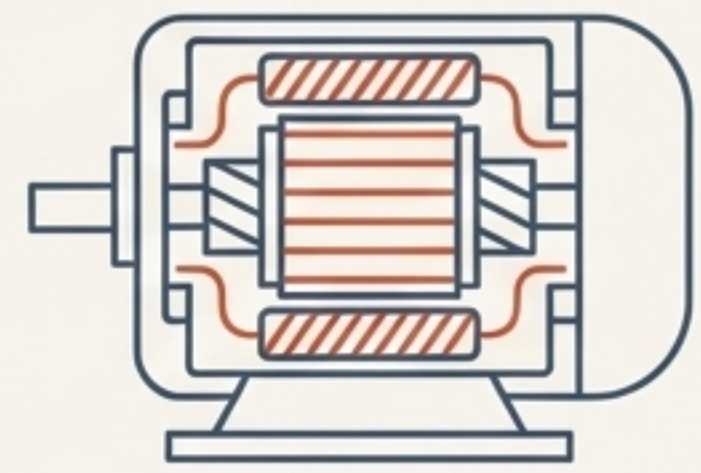
### Workshop Fabrication & Assembly

- Fabricate a project to within  $\pm 0,25$  mm dimensional tolerance.
- Sharpen drill angles according to material application.
- Prepare and execute manual metal arc welding and gas welding.



### Control Panel Wiring & Testing

- Mount, wire, and connect switch boards, distribution boards, and motor controls.
- Fault-find on control panels for open circuits, short circuits, and single-phase faults.



### AC/DC Machine Configuration

- Design and wire circuits for single-phase capacitor start motors (forward and reverse).
- Connect, test, and fault-find on DC series, shunt, and compound motors.

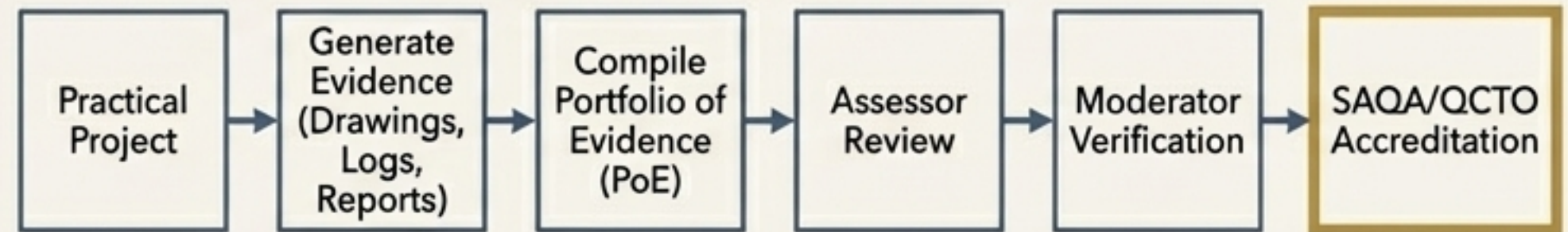


# Framework Component 3: The Assessment & Compliance Layer

## A Portfolio-Based Assessment System Aligned with SAQA and QCTO Standards

### Core Principles:

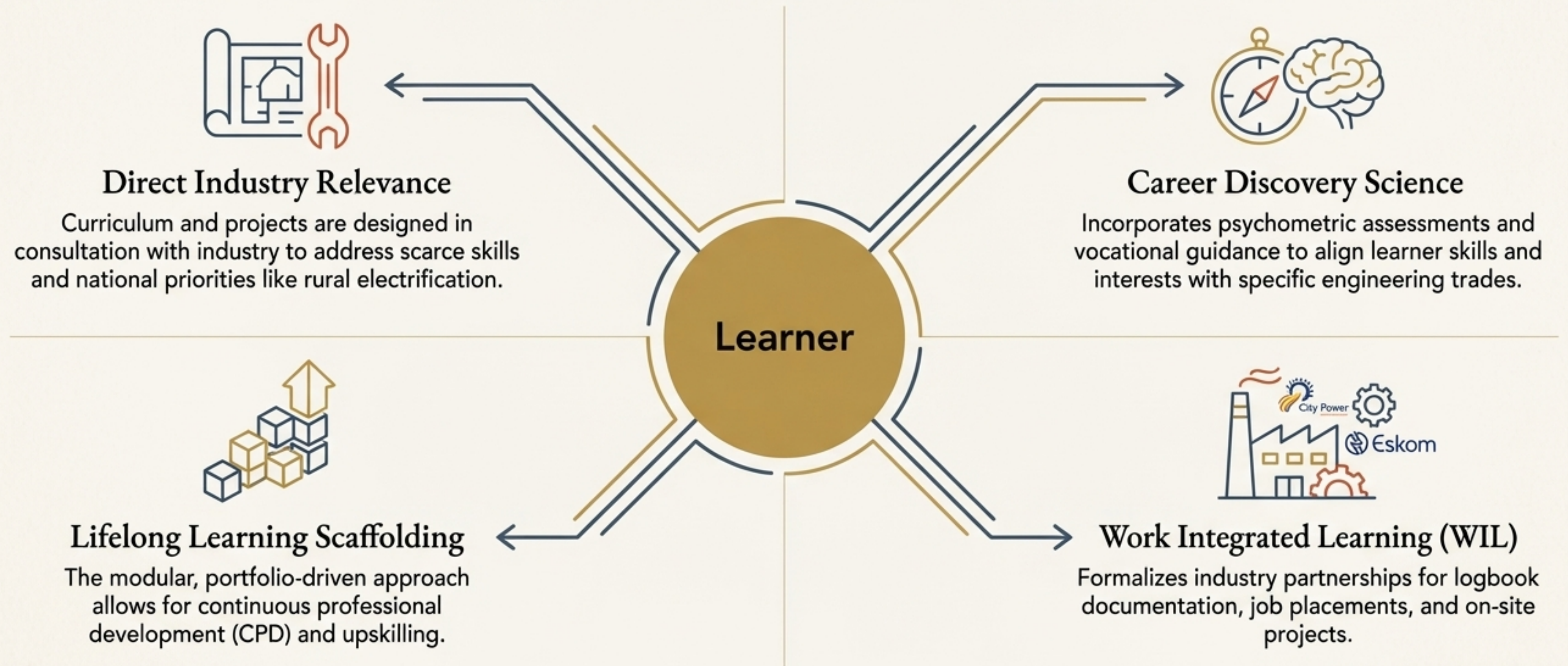
- **Outcome-Based Evaluation:** Assessment is based on demonstrated competence ("analysing a problem," "design a solution," "testing and reporting"), not just theoretical knowledge.
- **Portfolio of Evidence (PoE):** Learners compile a comprehensive PoE including project reports, schematics, fault-finding logs, and supervisor testimonials.
- **Assessor & Moderator Framework:** Utilizes trained assessors to ensure evaluation is Authentic, Valid, Current, and Sufficient.
- **NQF Level Alignment:** All outcomes are explicitly mapped to the South African National Qualifications Framework (NQF) levels for national recognition.





# Framework Component 4: The Career Pathway Integration

## Connecting Education to Career Discovery and Industry Needs





# The Vision: Impact and Implementation

## Powering the Future: A Case Study in Rural Electrification

### Project Abstract:

Application of the integrated framework to address the challenge of rural electrification in South Africa, where a backlog of 3.4 million households exists.

### Problem Analysis:

- Total rural unelectrified population = **10.0 million**
- Calculation:  $52.89 \text{ million} \times 0.31 \times 0.62$

### Solution Design:

Proposes the use of grid, off-grid, and PV-based hybrid systems, requiring skilled technicians for installation and maintenance.

### System Calculations Showcase:

$$\text{Demand Factor} = \frac{\text{Maximum Demand}}{\text{Connected Load}}$$

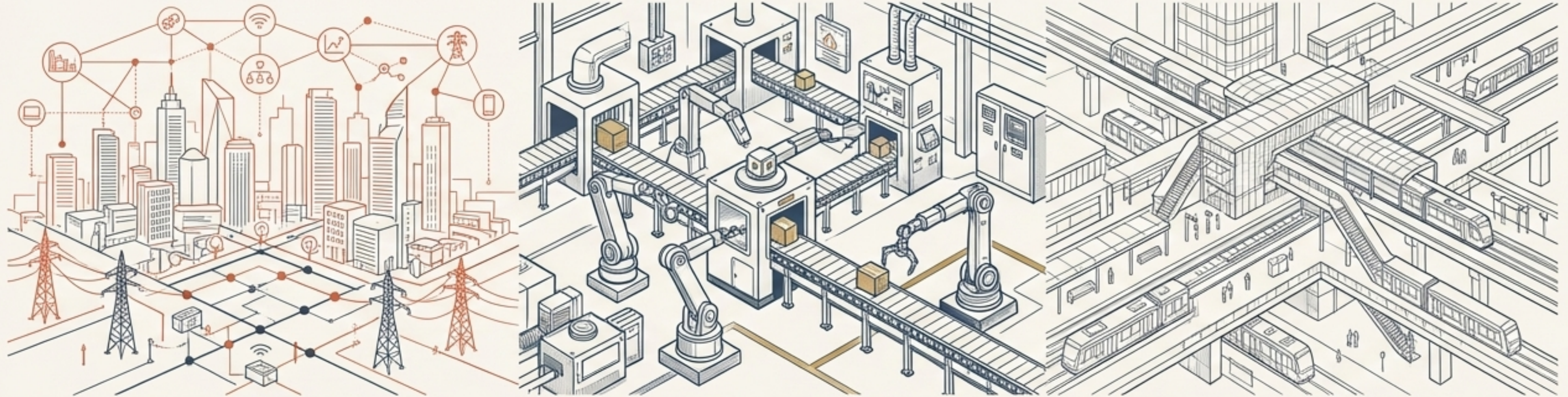
$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Load}}$$

$$\text{Real Power (3-phase): } P = \sqrt{3} \times V_c \times I_c \times \cos(\theta)$$





# Building a Generation of Future-Ready Engineers to Strengthen National Infrastructure



## Creating a Skilled Workforce

Graduates possess the verified skills to design, build, and maintain critical infrastructure, from smart grids and traffic management systems to industrial automation.

## Enhancing Economic Competitiveness

By closing the skills gap, the framework supports the Industrial Policy Action Plan and strengthens local manufacturing and technology sectors.

## Setting a New Benchmark for TVET

Establishes a model for excellence in technical education that is integrated, compliant, and responsive to the needs of the 21st-century economy.

***"Engineering has existed since ancient times...exploiting basic mechanical principle to develop useful tools object. This framework continues that legacy for the digital age."***



# A Foundation of Rigorous Research, Curriculum Design, and Intellectual Property

## Selected Curriculum & Research Projects

- Implementation and framework national qualification and national trade examination curriculum
- Career Discovery Science Application and Engineering Electrical Combination Framework
- AI Fluency Program (collaboration with Sci-Bono ICT Academy)
- Smart Factory Enhanced with Artificial Intelligence (DL I4.0 FACTORY-AI)
- Advanced Didactic Laboratories & AI-Enhanced Systems

## Patents & Formal Submissions

| Type       | Title/Focus                               | Application No. | Status  |
|------------|-------------------------------------------|-----------------|---------|
| Patent     | Engineering Master Doctoral (Rural Focus) | 520520          | Granted |
| Curriculum | Career Discovery... NSF Learning Journey  | 30              | Granted |
| Framework  | Security, Safety, Defense Facilitation... | 520525          | Granted |



# From a Fragmented System to an Integrated Future

**The Challenge:** A disconnected and outdated technical education system.

**The Journey:** A deliberate path of mastering foundational skills, building advanced systems, and engaging with the regulatory environment.

**The Solution:** The Tshingombe Integrated Framework—a proven, multi-layered model for developing the next generation of engineers.

This framework offers a clear, credentialed, and future-proof pathway to create a technically skilled workforce capable of building and maintaining South Africa's critical infrastructure.

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